USDA
NATURAL RESOURCES
CONSERVATION SERVICE
MARYLAND
CONSERVATION
PRACTICE STANDARD

WASTE STORAGE FACILITY

CODE 313
(Reported by No.)

DEFINITION

A waste impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.

PURPOSE

To temporarily store wastes such as manure, wastewater, and contaminated runoff as a function of an agricultural waste management system.

CONDITIONS WHERE PRACTICE APPLIES

The storage facility is a component of a planned agricultural waste management system.

Temporary storage is needed for organic wastes generated by agricultural production or processing.

The storage facility can be constructed, operated and maintained without polluting air or water resources.

Soils, geology, and topography are suitable for construction of the facility.

The practice applies to facilities utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.

Fabricated structure facilities applies to tanks, stacking facilities, and pond appurtenances. Storage tanks are used for liquid and slurry wastes and may be: (1) open roofed or covered, (2) within or outside an enclosed housing, or (3) beneath slotted floors. Stacking facilities are used for wastes that behave as a solid and may be open or roofed.

This practice does not apply to Waste Treatment Lagoons (359), even though they may have paved ramps or linings.

CONSIDERATIONS

Plans and specifications for waste storage structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Location

The following factors must be considered in selecting a site for waste storage structures: proximity of the structure to the source of wastes, access to other facilities, ease of loading and emptying wastes, appropriate health regulations, location of floodplains, direction of prevailing winds to minimize odors, and location relative to wells, milking centers and nearby homes.

If the only practical alternative is to locate the structure within the 100-year floodplain, the facility must be designed or modified to minimize potential harm to or within the floodplain.

Environmental Protection

All disturbed land surfaces shall be vegetated or otherwise stabilized to control soil erosion. The location, layout, and design of the facilities should be compatible with the surrounding landscape. Existing landforms and vegetation, along with land shaping and vegetative plantings, shall be considered to minimize an adverse impact upon visual resources.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service

An auxiliary (emergency) spillway and/or additional embankment height should be considered to protect the embankment. Factors such as drainage area, pond size, precipitation amounts, downstream hazards, and receiving waters should be evaluated in this consideration.

Nonpolluted runoff should be excluded to the fullest extent possible except where its storage is advantageous to the operation of the agricultural waste management system.

Operational Considerations

Methods of filling and emptying agricultural waste storage facilities should be considered in design.

Size, shape and location of openings in covered holding tanks should accommodate the characteristics of scrapers, conveyors, tractors or other equipment used to place or push wastes into the tank as well as equipment for agitating and emptying.

With open holding tanks, central loading from an elevation at or above the top of the sidewall allows more complete and uniform filling, particularly with manure containing bedding.

Solid organic wastes such as manure with bedding will produce seepage as a result of waste degradation or exposure to precipitation. This seepage will concentrate in low areas of storage facilities and methods should be provided for its containment and safe utilization. Provision of a roof with good side ventilation will minimize seepage accumulation. Without good ventilation use of a roof may tend to increase odor problems.

Safety Provisions

Design shall include appropriate safety features to minimize the hazards of the facility.

Disposal facilities

Special waste handling equipment shall be available to remove waste materials from agricultural waste storage facilities and processing it for energy, or applying it to the land at the locations, times, and rates shown in the overall waste management plan. Commercial agitators, pumps, conveyors, liquid manure spreaders, and irrigation, plow-down, or subsod injection equipment are available for liquid and slurry wastes. Conventional loading and spreading equipment can be used for solid wastes.

Care shall be exercised so that emptying and disposal is scheduled to be compatible with weather, land availability, stage of crop growth, and labor availability, and meets the requirements specified in the nutrient management plan.

Operation and Maintenance

An operation and maintenance plan shall be developed before construction that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. The plan shall contain the operational requirements for emptying the storage facility. This shall include the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, for ponds, the plan shall include the requirement that following storms, waste shall be removed at the earliest environmentally safe period to ensure that sufficient capacity is available to accommodate subsequent storms.

Service life and durability

Planning, design and construction shall insure that the structure is sound and of durable materials commensurate with the anticipated service life, initial and replacement costs, maintenance and operation costs, and safety and environmental considerations.

CRITERIA

General Criteria

Design Storage Volume - The volume of the structure shall be large enough to store accumulated wastes, bedding, wash water, and needed dilution water for the maximum period during which such wastes cannot be processed for energy or be applied to the land because of operational restrictions, weather, or crops. The minimum allowable

storage period shall be 90 days. Provisions shall be made to ensure that outside clean runoff does not flow into the structure. If suitable provisions cannot be made, however, the anticipated volume of runoff likely to enter the structure must be included in the required volume. The design capacity must allow for any direct rainfall and snow during the storage period. An allowance of at least 1.0 ft shall be provided for freeboard.

Waste production by livestock and poultry varies widely and should be based on actual production for individual farm operations. Variations are due to climate, type of feed, and livestock production methods. Table 2 is a general guide to manure production for various animals. Additional guidance may be found in the Agricultural Waste Management Field Handbook.

Use of bedding at the rate of 4 pounds per cubic foot of manure can be expected to increase the volume of manure production by about 30 percent. Use actual records for bedding amounts when available.

The volume of wash water should be determined by actual measurement, estimated by Table 3, or based on estimated quantities of the operator.

As a minimum, the design storage volume shall consist of the total of the following as appropriate:

a) Manure, wastewater, and other wastes accumulated during the storage period.

b) Normal precipitation less evaporation on the surface area of the facility during the storage period.

c) Normal runoff from the facility's drainage area during the storage period.

d) 25-Year, 24-hour precipitation on the surface of the facility.

e) 25-year, 24-hour runoff from the facility's drainage area.

f) Residual solids after liquids have been removed. A minimum of 6 inches shall be provided for tanks.

g) Additional storage as may be required to meet management goals or regulatory requirements.

The design storage volume for a waste storage facility is equal to its required volume.

Inlet - Inlets shall be of any permanent type designed to resist corrosion, plugging, and freeze damage incorporating erosion protection as necessary. Inlets from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings or other confined spaces.

Safety - Adequate maneuvering space shall be provided for operating loading and unloading equipment. Pushoffs must be structurally sound and must be provided with railings, safety bars, or other devices to prevent humans, animals, and equipment from falling into the facility. Ventilation and warning signs must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings. Ramps shall be grooved or rough concrete for adequate traction and be on a slope no steeper than 10:1. For floor level push-in type holding tanks and stacking areas, the floor should slope moderately (0.2 to 0.3%) away from the entrance. Equipment operates best with a straight line push. Provisions shall be made for removing liquids that accumulate in solid waste facilities from precipitation or other sources.

Protection - Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

Flexible membranes - Flexible membranes shall meet or exceed the requirements of flexible membrane linings specified in NRCS Practice Pond Sealing or Lining.

Pond Criteria

Location - Waste storage ponds, if located within floodplains, shall be protected from inundation or damage from a 25-year flood event.

Soil and Foundation - The pond shall be located in impervious soils with acceptable permeabilities or the pond shall be lined. Information and guidance on controlling seepage from waste storage ponds can be found in the Agricultural Waste Management Field Handbook (AWMFH), Chapter 7. The pond shall have a bottom elevation that is a minimum of 2 feet above the high water table.

Site soil characteristics will be investigated by borings made at least two feet below the planned waste storage pond bottom. Waste storage ponds must be placed in impervious soils or soils suitable for sealing.

Soils in regions where fractured limestone exists must be sealed with at least 24 inches of compacted clay material before using the waste storage pond. Sandy soil or other soil that may not be self-sealing will be treated with 12 inches of compacted clay, an approved sealant or liner, or a combination of these. The waste storage pond bottom shall be watertight, sealed from groundwater, before the waste storage pond is used.

Outlet - No outlet shall automatically release storage from the required storage volume. Manually operated outlets shall be of permanent type designed to resist corrosion and plugging.

Embankments - The minimum elevation of the top of the settled embankment shall be 1 foot above the required storage volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top width shall be 8 feet. The combined side slopes of the settled embankment shall be not less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical.

Emptying facilities - Some type of facility shall be provided for emptying the pond. It may be a dock, a pumping platform, a retaining wall, or a ramp. Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical or flatter. Steeper slopes may be used if special traction surfaces are provided.

Provision shall be made for periodic removal of accumulated solids to preserve storage capacity. The anticipated method for doing this must be considered in planning, particularly in determining the size and shape of the pond and type of seal, if any.

Safety - The pond shall be fenced and warning signs posted to prevent children and others from using it for other than its intended purpose.

Fabricated Structure Criteria

Foundation - The foundations of waste storage structures shall be proportioned to safely support all superimposed loads without excessive movement or settlement.

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement should be calculated from site specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 1 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

Structural Loadings - Waste storage structures shall be designed to withstand all anticipated loads including internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table, and frost or ice pressure and load combinations in compliance with this standard and applicable local building codes.

The lateral earth pressure should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in TR-74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 4 shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the structural stiffness or wall yielding as follows:

- Rigid frame or restrained wall. Use the values shown in Table 4 under the column "Frame Tanks," which gives pressures comparable to the at-rest condition.

- Flexible or yielding wall. Use the values shown in Table 4 under the column "Freestanding Wall," which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

Internal lateral pressure used for design shall be 65 lbs/ft^2 where the stored waste is not protected from precipitation. A value of 60 lbs/ft^2 may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used if supported by measurement of actual pressures of the waste to be stored. If heavy equipment will be operated near the wall, an additional two feet of soil surcharge shall be considered in the wall analysis.

Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structure Due to Use, and in ASAE EP393.2, Manure Storages, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon capacity shall be used.

If the facility is to have a roof, snow and wind loads shall be as specified in ASAE EP288.5, Agricultural Building Snow and Wind Loads. If the facility is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

Structural Design - The structural design shall consider all items that will influence the performance of the structure, including loading assumptions, material properties and construction quality. Design assumptions and construction requirements shall be indicated on the plans.

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance must be indicated on the construction drawings. The openings in covered tanks shall be designed to accommodate equipment for loading, agitating, and emptying. These openings shall be equipped with grills or secure covers for safety, and for odor and vector control.

All structures shall be underlain by free draining material or shall have footing located below the anticipated frost depth.

Potential uplift pressures shall be eliminated by drainage or be included in the structural design (including buoyancy and flotation). A factor of safety of 1.2 should be used in structural design if drainage is not provided

Minimum requirements for fabricated structures are as follows:

* Steel. “Manual of Steel Construction”, American Institute of Steel Construction.

* Timber. “National Design Specifications for Wood Construction”, American Forest and Paper Association.

* Concrete. “Building Code Requirements for Reinforced Concrete, ACI 318”, American Concrete Institute.

* Masonry. “Building code Requirements for Masonry Structures, ACI 530”, American Concrete Institute.

* Slabs on grade. Slab design shall consider the required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Where applied point loads are minimal and liquid-tightness is not required, such as barnyard and feedlot slabs subject only to precipitation, and the subgrade is uniform and dense, the minimum slab thickness shall be 4 inches with a minimum joint spacing of 10 feet. Joint spacing can be increased if steel reinforcing is added based on subgrade drag theory.

* For applications where liquid-tightness is required such as floor slabs of storage tanks, the minimum thickness for uniform foundations shall be 5 inches and shall contain distributed reinforcing steel. The required area of such reinforcing steel shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, "Design of Slabs-on-Grade".

* When heavy equipment loads are to be resisted and/or where a non-uniform foundation cannot be avoided, an appropriate design procedure incorporating a subgrade resistance parameter(s) such as ACI 360 shall be used.

* Coatings - Coatings shall be approved in accordance with procedures in the National Engineering Manual (210-512.20 to 512.23).

* Glass fiber reinforced plastics/resins and glass-fused steel - Products shall be approved in accordance with procedures in the National Engineering Manual (210-512.20 to 512.23).

Safety

Warning signs, fences, ladders, ropes, bars, rails, and other safety devices and precautions shall be provided as appropriate for safety of humans and livestock and to prevent use of the facilities for purposes other than intended.

If the area is used for livestock, the structure should be fenced as necessary to protect the structure and livestock. Near urban areas, fencing may be necessary to control access and exclude traffic that might damage the structure or to prevent serious injury or death to trespassers.

Table 1 - Presumptive Allowable Bearing Stress Values[1]

Foundation Description	Allowable Stress
Crystalline Bedrock	12000 psf
Sedimentary Rock	6000 psf
Sandy Gravel or Gravel	5000 psf
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3000 psf
Clay, Sandy Clay, Silty Clay, Clayey Silt	2000 psf

[1]Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)

TABLE 2
DAILY MANURE PRODUCTION
(not including bedding, wash water, or dilution water)

Animal	Cubic Feet/Day per 1000 lbs. of animal weight
Dairy Cattle	1.4
Beef Cattle	1.0
Horses	0.8
Feeder Swine	1.1
Breeder Swine	0.8
Sheep	0.6
Poultry - Layers, Broilers	1.25

TABLE 3
VOLUME OF MILKING CENTER WASTES

Washing operation	Water Volume
Bulk Tank	
Automatic	50-60 gal/wash
Manual	30-40 gal/wash
Pipeline	
In parlor (Volume increases for long lines in a large stanchion barn.)	75-125 gal/wash
Pail milkers	30-40 gal/wash
Misc equipment	30 gal/day
Cow prep	
Automatic	¼-½ gal/wash per cow
Estimated average	2 gal/wash per cow
Manual	¼-½ gal/wash per cow
Parlor floor	40-75 gal/day
Milkhouse floor	10-20 gal/day

Ref: MWPS-1, Structures and Environment Handbook, 11th Ed.

TABLE 4
LATERAL EARTH PRESSURE VALUES[1]

Soil		Equivalent Fluid Pressure ($lb/ft^2/ft$ of depth)			
		Above seasonal high water table[2]		Below seasonal high water table[3]	
Description[4]	**Unified classification[4]**	**Free-standing wall**	**Frame tanks**	**Free-standing wall**	**Frame tanks**
Clean sand, gravel, or sand-gravel mixtures[5] (maximum 5 percent fines)	GP, GW, SP, SW	30	50	80	90
Gravel, sand, silt, and clay mixtures (less than 50% fines) Course sands with silt and/or clay (less than 50% fines)	All gravel/sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35	60	80	100
Low-plasticity silts and clays with some sand and/or gravel or fine silty and clayey sands (50% or more fines) Fine sands with silt and/or clay (less than 50% fines)	CL, ML, CL-ML, SC, SM, SC-SM	45	75	90	105
Low to medium-plasticity silts and clay with little sand and/or gravel (50% or more fines)	CL, ML, CL-ML	65	85	95	110
High plasticity silts and clays (liquid limit more than 50)[6]	CH, MH	--	--	--	--

1 For lightly compacted soils (85% to 90% maximum standard density). Includes compaction by use of typical farm equipment.
2 Also below seasonal high water table if adequate drainage is provided.
3 Includes hydrostatic pressure.
4 All definitions and procedures in accordance with ASTM D 2488 and D 653.
5 Generally, only washed materials are in this category.
6 Not recommended. Requires special design if used.

SPECIFICATIONS

1. The construction of agricultural waste storage facilities shall comply with all federal, state and local laws, rules and regulations governing waste management, pollution abatement, health and safety. The owner or operator shall be responsible for securing all required permits and approvals and for performance in accordance with appropriate laws, rules and regulations.

2. All phases of construction shall comply with the appropriate standards and specifications for the work items including, but not restricted to:

   a. Site preparation
   b. Concrete

3. All components of the completed structure shall conform to the lines, grades, elevations, dimensions and materials specifications shown on the plans.

4. All material shall be as specified on the construction drawings. The contractor shall be responsible for furnishing material certification. These certification slips shall be retained with the "as built" plans.

5. All waste storage structures are considered to be essentially watertight for the life of the structure. All joints, seams, cracks, splices, etc. shall be sealed in the manner and with the materials specified on the construction plans. If joint sealant and method of sealing are not specified, it is the responsibility of the NRCS personnel to develop the specificities of sealing the structures prior to start of construction.

6. All footings and foundations should be placed a minimum of 1 foot below normal frost penetration.

7. Steel reinforcement shall be formed, located, spliced, and lapped as specified on the construction drawing.

8. Concrete shall meet the requirements of Maryland Department of Transportation, State Highway Administration Standard Specifications for Construction and Materials, Section 414, Mix No. 3.

9. All parts and components will be set or constructed to the elevations, lines, and limits specified on the construction plans.

10. Backfill material shall be as specified and shall be compacted to the density specified and placed to the height or elevations lines and slopes shown on the construction plans.

11. All disturbed areas shall be fertilized, seeded, and mulched or otherwise stabilized as required on the construction plans.

12. As-built plans or the equivalent documentation of changes during construction must be recorded on the drawings. (NEM Subpart F.)

13. The contractor should furnish a certification statement that he has constructed/assembled the non-NRCS designed structure in accordance with the specifications of the designer.

SUPPORTING DATA AND DOCUMENTATION

Field Data and Survey Notes

The following is a list of the minimum data needed:

1. System plan sketch.
2. Topographic survey of the site showing building locations, elevations at structure location and at outlets from barns, separators, etc., location of dwellings, wells, floodplains, etc.
3. Soils investigation showing seasonal high water table.
4. Operator data such as desired storage time and volumes of manure, bedding or wash water generated.

Design Data

Record on appropriate engineering paper. The following is a list of the minimum required design data:

1. Waste Management System Plan
2. Structure capacity
3. Structure design
4. Filling and emptying details, access, and equipment
5. Area grading plan
6. Vegetative plan
7. Details of foundation drainage, if required

Construction Check Data/As-built

Record on survey note paper, SCS-ENG-28. Survey data will be plotted in red. The following is a list of minimum data needed for As-builts:

1. Actual dimensions of installed structure
2. Installed facility for filling structure
3. Verification of adequate foundation preparation
4. Documentation of installation of foundation drainage
5. Documentation of reinforcing steel and proper concrete installation, if applicable
6. Condition of precast panels, if applicable
7. Certification that work meets plans and specifications

REFERENCES

1. *Agricultural Waste Management Field Handbook, Part 651*, USDA Soil Conservation Service, 1992.

2. *ASTM Standards, American Society for Testing and Materials*, Philadelphia, Pennsylvania

3. *Engineering Field Handbook, Part 650*, USDA Soil Conservation Service.

4. *Manure Management Handbook*, MD State Soil Conservation Committee, 1989.

5. *Maryland Technical Guide*, Section IV, Standards and Specifications for Nutrient Management System (MD-590), December 1993.

6. *Maryland Technical Guide*, Section IV, Standards and Specifications for Waste Management System (MD-312), December, 1990.

7. *Maryland Technical Guide*, Section IV, Standards and Specifications for Waste Utilization (MD-633), December, 1990

8. *Midwest Plan Service, Structures and Environment Handbook*, 1983.

9. *National Handbook of Conservation Practices*, USDA, Soil Conservation Service.

10. *Standard Specifications for Construction Materials*, Maryland Department of Transportation, State Highway Administration, Baltimore, Maryland, October 1993.